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Larvae of Nearshore Fishes in Oceanic Waters near Oahu, Hawaii

Thomas A. Clarke

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Larvae of Nearshore Fishes in Oceanic Waters near Oahu, Hawaii

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ABSTRACT

Larvae of over 50 families of nearshore fishes were taken in oceanic waters about 13 km offshore of the leeward (southwest) coast of Oahu, Hawaii during 1977–78. The five most frequently taken families (Labridae, Parapercidae, Serranidae, Gobiidae, and Carangidae) made up over 50% of the total nearshore larvae. Most other families were taken very infrequently. Comparison of catch data from three types of nets indicated that 1.25-m diameter bongo nets often sampled larvae as well or better than a 3-m Isaacs-Kidd trawl and that smaller, 70-cm diameter bongo nets were often as effective as the larger nets for certain abundant taxa. Only a few taxa showed evidence of seasonal patterns in abundance. Irregular temporal variability in abundance of some taxa may have been related to occasional recent influxes of surface water from closer to shore. Most larvae taken were late preflexion stage or older. Densities of even the most abundant taxa were rarely greater than 0.001 m^{-3}. The nearshore fish larvae were not dominated by taxa with large larvae or with larvae possessing apparent specializations to pelagic existence. Most taxa taken were pelagic spawners as adults, but larvae of demersal spawners were roughly as well represented as demersal spawners are among the nearshore fish fauna. Previous studies of waters closer to shore probably sampled insufficient volumes for any but a few exceptionally abundant taxa. Sampling with volumes filtered of the order of 10^4–10^5 m^3 will be necessary to determine if the dominant taxa taken by the present study are ever more abundant closer to shore.

Introduction

Most species of nearshore marine fishes have pelagic eggs or larvae which are subject to dispersal away from adult habitat. Consequently, recruitment to adult populations is controlled not only by survival during the pelagic stages but also by the probability of return of premetamorphoric larvae to inshore areas suitable for settlement. The role of egg and larval dispersal in the population dynamics of tropical inshore fishes has recently received much attention (McFarland and Ogden 1985). Losses due to dispersal away from suitable habitats may be more important in limiting recruitment of nearshore fish populations of steep sloped oceanic islands than populations along more extensive and broader continental coastlines (Walsh 1987). For the most part, aspects or consequences of dispersal have been inferred from shore-based studies of spawning and recruitment (Victor 1984), adult life-history characteristics (Barlow 1981), or ages of settlement estimated from otolith increments (Brothers and Thresher 1985). There is little direct knowledge of the distribution, density, and size composition of larvae of inshore fishes.

Most available data on fish larvae near oceanic islands are from relatively close to shore. Leis (1982) found that larvae within a few km of shore in Hawaii were dominated by a few species, most of which were demersal spawners. Larvae of most common inshore fish families with pelagic eggs were rare or absent. Larvae of several inshore families have been reported from oceanic waters well removed from adult habitats (Richards 1984), and some inshore taxa have larvae with apparent adaptations to pelagic existence (Leis and Rennis 1983). Based on abundance of certain groups of larvae *relative to total larvae* in a series of samples from Hawaii, Leis and Miller (1976) concluded that larvae of inshore families which spawn demersal eggs were more abundant close to shore and that larvae of families which spawn pelagic eggs were more abundant offshore. They did not, however, provide or compare actual densities of different types of larvae from different locations. In fact, there are few quantitative data

available on densities of larvae of inshore fishes in oceanic waters.

This paper reports on the larvae of inshore fishes taken in oceanic waters near the Hawaiian Islands. The larvae were taken during a 16-month long program that repeatedly sampled the upper layers with three different types of nets. Although the program was originally designed for investigation of vertically migrating oceanic fishes and the collections were dominated by oceanic taxa, larvae of inshore taxa were also regularly taken. The data on the latter provide the opportunity for more quantitative consideration of composition, abundance, and seasonality than was previously available for offshore waters and also permit more definitive comparison with data from areas closer to shore.

Methods

All samples were taken along a track roughly parallel to and ca. 13 km off the leeward coast of the island of Oahu, Hawaii (between 21°18′N, 158°15′W and 21°30′N, 158°23′W). Water depth along the transect was 2000 m or greater, and the macrozooplankton and micronekton in the area were dominated by oceanic species (Clarke 1980). Samples were taken on short cruises between August 1977 and October 1978. Most cruises were within 1–2 days of new moon of each lunar month during the period. Because of scheduling difficulties, there was no cruise in January 1978; the cruise for November 1977 was 4–5 days after full moon; and the cruise for February 1978 was at full moon. Thus 15 of the 16 lunar months covered were sampled, and 13 at or close to new moon. The cruises are subsequently referred to by year and month, e.g., 78-03 for March 1978. (New moon occurred twice in October 1978. For convenience, the cruise during the second new moon was designated 78-11 in spite of the fact that the cruise was during the last days of October.)

Nighttime oblique tows were taken with three types of nets. Detailed descriptions of the gear and procedures are given in Clarke (1983) and are only briefly summarized here. A 3-m Isaacs-Kidd midwater trawl (IK) with a body of ca. 6-mm mesh netting was towed at ca. 2 m/sec and fished between the surface and a mean maximum depth of 325 m. A large bongo net frame (BB) with 1.25-m diameter nets of ca. 2.5-mm mesh netting was towed at ca. 1.75 m/sec between the surface and a mean of 304 m depth. A standard 70-cm diameter bongo frame (SB) with nets of either 0.333- or 0.183-mm mesh netting was towed at ca. 1 m/sec between the surface and a mean of 224 m depth.

On most cruises, four IK tows were taken during the first night, and two BB plus four SB tows during the second. The IK tows, which covered ca. 12 km each, essentially sampled the entire transect twice (two tows along a roughly NNW course and two return tows on the reciprocal course). The BB tows, which covered ca. 10 km each, sampled the southern half of the transect twice (one tow headed NNW and the second on the reciprocal course). The SB tows, which only covered ca. 2 km each, were all taken sequentially along the southern end of the transect. The exceptions to the standard sampling were: only three IK tows on 77-09 and 77-12, no BB tows on 77-12, and only two or three SB tows on the first five cruises (77-8 through 77-12). Additionally, two IK samples were taken during each of two other cruises in the same area at full moon in both March and April, 1978. A total 62 IK samples, 28 pairs of BB samples, and 50 pairs of SB samples were examined.

All nets were equipped with flowmeters and time-depth recorders. For the few cases where one or the other device malfunctioned, the missing value of either flow or maximum depth was estimated from plots of flow vs. maximum depth of the satisfactory tows. Volumes sampled were determined from flowmeter data and mouth area. Because the sampling program was originally designed for vertically migrating mesopelagic fishes, the maximum depths were purposefully much greater than needed for sampling of inshore fish larvae. Current studies with opening–closing nets (Boehlert and Mundy, NMFS, Honolulu Laboratory) as well as preliminary analyses of nearshore fish larvae from many horizontal IK tows taken in the study area from 1969 to 1974 indicate that few, if any, occur deeper than ca. 100 m. Consequently, the total volume sampled by each tow was multiplied by the ratio of 100/maximum depth to provide the volume sampled in the upper 100 m only, a more appropriate value for this study.

The means (and ranges) of volumes sampled in the upper 100 m per tow by each type of net were IK—31,919 m^3 (23,400 - 56,250 m^3); BB (both nets)—6582 m^3 (3450 - 15,200 m^3); SB (both nets)—781 m^3 (326 — 1604 m^3). For each type of gear, the variability in volume filtered per tow was almost exclusively due to variability in flow/time (as opposed to deviations from the wire out schedules or total duration of tow) and was apparently caused by unexplained variation in the ship's speed. The effect was compounded because maximum tow depth was inversely correlated with flow/time. Consequently, both the volume/tow and the ratio of 100/maximum depth were higher for faster tows.

There were also great differences in the relative volumes filtered per cruise by each type of gear. For individual cruises, the IK tows filtered 6.5–20.4 times the volume filtered by the BB tows and 23.5–83.9 times that filtered by the SB tows. Overall the IK tows filtered 10.53 times the volume filtered by the BB tows and 46.88 times that by the SB tows. The volume filtered by the BB tows was 3.3–12.3 times the SB volume for individual cruises and 4.45 times the SB volume overall. For the 13 cruises where at least three SB tows were taken, the range of BB:SB

volumes filtered was 3.5–6.8. (The above comparisons involving the BB exclude 77-12 when no BB tows were taken.)

Samples were preserved and held in 4% formaldehyde-seawater solution. The IK samples were sorted under 3 × magnification. Subsequent rechecking of selected samples under a dissecting microscope at 10 × indicated that negligible numbers of fish larvae over 5–6 mm long and 5–10% of the smaller larvae were missed by the routine procedure. The BB and SB samples were sorted under a dissecting microscope at 10 × . Rechecking indicated that practically no fish larvae were missed by routine sorting. Standard lengths or, for preflexion larvae, notochord lengths were measured to the nearest 0.5 mm. For both types of bongo samples, the catches and volume sampled from both nets combined were used for analyses and presentation. The SB samples with 0.183-mm nets obviously retained smaller larvae than those with 0.333-mm nets, but since such small larvae attributable to nearshore families were so infrequent in the samples, the data from both types of SB samples were pooled for analyses.

Fish larvae from inshore taxa were separated from those of oceanic groups. The latter, mostly myctophids and stomioids, usually constituted over 90% of the total larvae. Two major groups which are solely or partly inshore, the Pleuronectiformes and Anguilliformes, were not further identified and are not considered in this paper. Almost all late preflexion and postflexion larvae were readily identifiable to either nearshore or oceanic taxa, and the former were usually identifiable to family. Among the very small (<2–3 mm) early preflexion larvae there were a substantial number that I did not definitely class as either oceanic or nearshore. Based on my observations of larger, identifiable oceanic larvae during the sorting and identification process, the great majority of these "unknown" preflexion larvae were probably of oceanic perciform or perciform-like taxa, such as melamphaids, *Howella* spp. and similar epigonids, stromateoids, or perhaps even some myctophiforms, whose very early larval stages have not been described. These unknown preflexion larvae were smaller and less-developed than the smallest identifiable specimens of most nearshore taxa, and there were no apparent "connecting links" between them and larger nearshore larvae in the material. (Fairly continuous series of sizes and developmental stages were present for the few nearshore taxa whose size range included very small larvae.)

Identification of nearshore larvae below family was variably possible. Many families taken almost certainly included more than one form of larvae, but numbers were too low to assemble definitive series for reliable discrimination. In other cases, distinct forms were evident and often attributable to genera or species known from Hawaii based upon meristics, previously published descriptions, or developmental series that were assembled from available material. In many families, where the meristics of different genera or species overlap, tentative or "most likely" identifications of different forms were based upon frequency distribution of counts. Frequently, forms could not be discriminated from each other at the smallest sizes. For most larvae identified to genus it was usually not certain that either one or more than one species were included; consequently, I have omitted the conventional "sp." or "spp." after generic names.

Most nearshore taxa were taken very infrequently, and even for the abundant taxa, data from all cruises were pooled for density estimates and between gear comparisons. Even then, total catches of the SB and often the BB were ≤5 for many taxa and considered inadequate for further analyses. Catches of a few very abundant taxa were high enough for meaningful comparison of densities and size composition between cruises with high catches and the remainder of the data. Otherwise, numbers were too low and variability too high for meaningful within or between cruise comparisons. Size compositions were compared using the Kolmogorov-Smirnoff test; differences were considered significant if the resultant probability was ≤0.05. Interpretation of differences in density estimates was very conservative. Differences of less than ± 50% were considered likely to be due to chance and small numbers, and the data were carefully examined to assure that apparent differences were not due to one or two extremely high catches.

Results

A total of 5192 larvae were definitely and 74 tentatively identified to one of 53 families of nearshore fishes. Some families could be further broken down into size groups, lower taxa, or recognizably different forms, with the end result of 122 different categories of nearshore larvae (Table 1). Additionally there were two unidentified forms of larvae, each represented by seven individuals, which were probably nearshore forms but whose meristics were unattributable to any known Hawaiian families. (One of the unidentified forms resembled uranoscopelids most closely and the other, apogonids.) Only 26 postflexion specimens, some damaged, were neither clearly of oceanic families nor definitely attributable to any nearshore family, but there were 550 "unidentified preflexion" larvae.

The nearshore larvae were dominated by a few forms (Table 2). The 20 most abundant families made up over 90% of the total. The Labridae alone accounted for almost 25% of the total, and the five most abundant families accounted for over half. Among lower taxa, *Parapercis*, Labrid S, and *Luzonichthys earlei* made up almost 25% of the total larvae, and the top twenty forms made up over 50%. For the great majority of larval forms listed in Table 1, the numbers of specimens collected were so few that further comment beyond the record of their numbers and size

Table 1

Numbers and size ranges of nearshore fish larvae collected from oceanic waters near Oahu, Hawaii during 1977–78. For each taxon, the number and size range of positively identified specimens are followed by the number and size range of specimens that could only be tentatively identified ("No.?").

Taxon	No.	Size (mm)	No.?	Size (mm)
Argentinidae				
Glossanodon struhsakeri	2	(8–8.5)	2	(3–4)
Synodontidae	6	(4–15)		
Trachinocephalus myops	23	(6.5–32)		
Synodus	169	(4.5–40)	5	(4.5–17)
Chlorophthalmidae	8	(8–65)	1	(11)
Moridae	1	(39)		
Carapidae	29	(13–75)		
Ophidiidae				
Brotula multibarbata	16	(3.5–60)	2	(3–3.5)
Ophidiid X	14	(6.5–40)		
Antennariidae	20	(2.5–12)		
Ogcocephalidae	5	(3–6.5)	1	(2.5)
Polymixiidae				
Polymixia	2	(21–35)	6	(2.5–4.5)
Holocentridae				
Holocentrinae	13	(2.5–12.5)	7	(1.5–2.5)
Myripristinae	17	(3.5–8)		
Zeniontidae				
Zenion	28	(4–38)		
Caproidae				
Antigonia	10	(3–19.5)	1	(4)
Fistulariidae				
Fistularia	11	(6–80)		
Scorpaenidae	38	(2.5–5.5)	4	(3–3.5)
Scorpaeninae	60	(5.5–20)		
Scorpaenine E	15	(7–11.5)	1	(5.5)
Scorpaenine F	12	(8.5–16)		
Scorpaenodes	21	(5–9)	2	(4.5–8.5)
Dendrochirus barberi	5	(4.5–11)		
Setarchinae	22	(3.5–26)	1	(4)
Dactylopteridae	5	(4–38)		
Caracanthidae	2	(8–9)		
Acropomatidae				
Synagrops	19	(3.5–25)		
Epigonidae				
Epigonus	12	(4.5–33)	1	(4.5)
Apogonidae				
Pseudamiops	7	(6–9)		
Apogoninae	36	(3–24)		
Apogonine A	41	(4–22)	2	(5–5.5)
Carangidae	267	(2.5–6)	4	(3)
Decapturus	21	(5.5–16)		
Selar crumenophthalmus	10	(4.5–8)	12	(4.5–5.5)
Scomberoides lysan	4	(5.5–19)	2	(5–6)
Seriola	13	(5–9.5)		
Caranx	2	(4)	1	(3.5)
Chaetodontidae				
Chaetodon	37	(3–31)		
Forcipiger	1	(7)		
Cirrhitidae	20	(5–42)	6	(4.5–7.5)
Lutjanidae				
Lutjanus	49	(3–10)	2	(3.5–4)
Aprion virescens	9	(3.5–5)	1	(4)
Pristopomoides	11	(3.5–15)	1	(4)
Mullidae	212	(2.5–29)	2	(2)
Malacanthidae	4	(10.5–34)	1	(3.5)
Pomacanthidae				
Centropyge	26	(2.5–5)		
Centropyge L3	102	(4–22)	9	(14–21)
Centropyge S3	17	(6–20)	3	(20–21)
Priacanthidae	1	(10)	1	(6.5)
Serranidae	21	(2–5)	9	(2.5–4)
Luzonichthys earlei	260	(4–31)		
Serranid A	70	(5–18)		
Serranid B	12	(5–27)		
Serranid C	12	(4–22)	1	(5)
Serranid A′	3	(4–4.5)		
Serranid D	12	(4.5–9)		
Serranidae	9	(6.5–25)		
Pseudogrammidae	26	(5–13)		
Callanthiidae				
Grammatonotus laysanus	6	(4.5–25)	1	(5.5)
Symphysanodon	100	(3–32)		
Sphyraenidae				
Sphyraena	42	(4–11)	1	(4.5)
Labridae	26	(3–5)	4	(3.5–4)
Labrid S	483	(3.5–8)	7	(3–4)
Labrid B	77	(4–8)	1	(4)
Labrid N	96	(3.5–12)	1	(3.5)
Labrid 3	149	(3.5–18)		
Labrid T	115	(4.5–14.5)	4	(4.5–6.5)
Labrid G	80	(5.5–13)	2	(4–5)
Labrid X	34	(5.5–13.5)	15	(4.5–9.5)
Labrid O	43	(7.5–17)	1	(10.5)
Labrid E	46	(9–21.5)	2	(6–9.5)
Labrid T′	13	(6–14)		
Labrid D	9	(5–12.5)		
Labrid S′	17	(4.5–7.5)		
Polylepion russelli	1	(12)		
Scaridae				
Scarine A	14	(4–7.5)		
Scarine B	38	(4.5–10)	1	(3)
Calotomus	27	(5.5–17)	1	(6.5)
Pomacentridae	36	(3–6)	13	(3–4)
Chromis A	9	(8.5–15)	1	(14)
Chromis B	5	(7–12)	5	(5–14)
Chromis C	4	(9.5–14.5)	1	(11)
Plectroglyphidodon imparipennis	3	(6.5–13.5)		
P. johnstonianus	2	(19–21)		
Stegastes fasciolatus	5	(11.5–14)	1	(5)
Dascyllus albisella	2	(7.5–9.5)	1	(6)
Abudefduf abdominalis	1	(6.5)		
Acanthuridae	25	(2–6)		
Naso	99	(2.5–37)	18	(1.5–2)
Acanthurus	51	(4–26)		
Ctenochaetus	53	(6–30)		
Zebrasoma flavescens	5	(5.5–23)		
Champsodontidae				
Champsodon fimbriatus	8	(5–17)		

Table 1 (continued)

Taxon	No.	Size (mm)	No.?	Size (mm)
Creediidae				
Limnichthys donaldsoni	1	(10)		
Crystallodytes cookei	4	(5.5-11)		
Percophididae				
Chrionema	5	(15-32)		
Bembrops filifera	2	(9-22)		
Mugiloididae				
Parapercis	521	(2-11)	12	(2-3.5)
Blenniidae	1	(3.5)		
Salariini	59	(3-30)	2	(4-4.5)
Omobranchini	9	(3.5-5.5)		
Plagiotremus	3	(21-37)		
Schindleriidae				
Schindleria praematura	44	(3-15)	1	(4.5)
Schindleria pietschmanni	7	(4-12.5)		
Ammodytidae	17	(7.5-23)		
Eleotridae				
Eleotris sandwicensis	90	(3.5-7.5)	2	(4)
Gobiidae	30	(4-15)	5	(2.5-7)
Goby A	90	(7-25)		
Goby B	55	(5.5-12	1	(4.5)
Goby D-3	37	(5.5-10.5)	4	(8.5-10)
Goby D-5	42	(4.5-11.5)	3	(8-10.5)
Goby R	13	(7-10.5)	2	(5.5)
Goby C	3	(7-8.5)		
Gobiidae (continued)				
Goby D-6	3	(12-14.5)		
Goby D-7	1	(6.5)		
Eviota epiphanes	33	(2.5-7)	2	(3-4.5)
Bathygobius	7	(3-6.5)	1	(6)
Asterropteryx semipunctatus	3	(3-5)		
Psilogobius mainlandi	1	(5.5)		
Kellogia oligolepis	3	(7-8.5)		
Microdesmidae				
Ptereleotris heteropterus	80	(3-28)	4	(3.5-7.5)
Gunnellichthys curiosus	29	(9-40)		
Callionymidae	77	(2-8.5)	2	(2.5-3)
Callionymid A	69	(2.5-5.5)	2	(2.5-5)
Draconettidae	1	(30)		
Tetraodontiformes	2	(3)		
Balistidae	8	(3-60)		
Monocanthidae	2	(3-3.5)	1	(3.5)
Tetraodontidae	44	(2-23)	3	(2-2.5)
Diodontidae	21	(2.5-20)	1	(3)
Ostraciidae	4	(2-21.5)	2	(2)
Unident. A	6	(11-18)	1	(4)
Unident. B	7	(5-21)		
Unident., postflexion	26	(3-15)		
Unident., preflexion	550	(1-7)		

Table 2

Ranks by number of specimens captured, numbers captured, and cumulative percentages of total nearshore fish larvae for the 20 most abundant families (left columns) and the 20 most abundant lower taxa (right columns) taken in samples from oceanic waters near Oahu, Hawaii, 1977-78.

Families			Lower taxa		
Rank	No.	Cum. %	Rank	No.	Cum. %
1. Labridae	1222	23.6	1. *Parapercis*	521	10.0
2. Parapercidae	521	33.6	2. Labrid S	483	19.3
3. Serranidae	400	41.3	3. *Luzonichthys earlei*	260	24.4
4. Gobiidae	334	47.7	4. *Synodus*	169	27.6
5. Carangidae	332	54.1	5. Labrid 3	149	30.5
6. Acanthuridae	251	58.9	6. Labrid T	115	32.7
7. Mullidae	212	63.0	7. *Centropyge* L3	102	34.7
8. Synodontidae	203	66.9	8. *Symphysanodon*	100	36.6
9. Scorpaenidae	177	70.3	9. *Naso*	99	38.5
10. Pomacanthidae	157	73.3	10. Labrid N	96	40.4
11. Callionymidae	148	76.2	11. *Eleotris sandvicensis*	90	42.1
12. Microdesmidae	113	78.4	12. Goby A	90	43.8
13. *Symphysanodon*	100	80.3	13. *Ptereleotris heteroptera*	80	45.3
14. Eleotridae	90	82.1	14. Labrid G	80	46.9
15. Apogonidae	86	83.7	15. Labrid B	77	48.4
16. Scaridae	81	85.3	16. Serranid A	70	49.7
17. Pomacentridae	76	86.8	17. Callionymid A	70	49.7
18. Blennidae	74	88.2	18. Goby B	55	52.2
19. Lutjanidae	73	89.6	19. *Ctenochaetus*	53	53.2
20. Schindleriidae	52	90.6	20. *Acanthurus*	51	54.2

Table 3

Estimated densities of frequently collected taxa of nearshore fish larvae in the upper 100 m of oceanic waters near Oahu, Hawaii, 1977–78. Densities were calculated from catches of three different nets: a 3-m Isaacs-Kidd mid-water trawl (IK), 1.25-m diameter bongo nets (BB), and 70-cm diameter bongo nets (SB). Values are not given for cases where the total catch was ⩽5 individuals. Densities based on all sizes or cruises are indicated by "all." Otherwise, inequalities under "Size" indicate inclusion of only large or small sizes of certain taxa, and cruise numbers (*see* text) under "Cruise" indicate separate consideration or exclusion ("x") of data from certain cruises with exceptionally high catches (*see* text).

Taxon	Size (mm)	Cruise	Density (No./1000 m³) IK	BB	SB
Synodus	all	all	0.031	0.456	0.604
	all	77-11	0.094	1.577	—
	<28	all	0.024	0.450	0.604
	<22	all	0.019	0.358	0.604
Apogoninae	all	all	0.015	0.190	0.314
Carangidae	all	all	0.097	0.559	0.942
	all	78-10	1.408	7.330	17.478
	all	x78-10	0.014	0.433	0.276
Lutjanus	all	77-08	0.060	1.560	—
Mullidae	all	77-08	0.094	2.618	55.594
	all	x77-08	0.015	0.126	0.601
	<10	all	0.014	0.342	2.488
	>9	all	0.006	0.027	0.048
Centropyge	all	all	0.065	0.119	0.217
	all	78-03	0.245	—	—
	<8	all	0.007	0.103	0.121
	>7	all	0.058	0.016	—
Luzonichthys earlei	all	all	0.078	0.380	0.894
	>20	all	0.040	0.098	0.097
	all	78-6	0.462	3.933	9.401
	<12	all	0.028	0.266	0.773
Serranid A	all	78-03	0.362	—	—
Symphysanodon	all	all	0.033	0.163	0.121
	all	78-03	0.309	0.698	—
Labrid S	all	all	0.094	1.433	0.942
	all	78-07	0.073	3.183	—
Labrid B	all	all	0.023	0.152	—
Labrid N	all	all	0.024	0.212	0.217
Labrid 3	all	all	0.039	0.320	0.362
	all	78-03	0.134	1.221	0.695
	<7	all	0.007	0.130	0.217
	>11	all	0.040	0.271	0.121
Labrid T	all	all	0.026	0.266	0.362
Labrid G	all	all	0.015	0.179	0.411
Labrid X	all	all	0.009	0.119	0.242
Naso	>6	all	0.028	0.038	—
Acanthurus	all	78-02 + 03	0.035	0.481	—
Ctenochaetus	all	78-02 + 03	0.111	0.298	—
*Parapercis*all	all	0.116	1.324	1.256	
	all	77-11	0.661	4.730	11.592
Eleotris sandvicensis	all	all	0.023	0.190	0.169
Goby A	all	all	0.028	0.163	0.121
Goby B	all	all	0.009	0.174	0.121
Goby D-3	all	all	0.010	0.087	—
Goby D-5	all	all	0.009	0.103	0.121
Ptereleotris heteroptera	all	all	0.022	0.114	0.411
	>11	all	0.007	0.060	0.145
Gunnellichthys curiosus	all	all	0.007	0.065	—
	>19	all	0.006	0.027	—
Callionymidae	all	all	0.027	0.336	0.628

ranges is not merited. Results for the more frequently taken taxa are presented in the following individual accounts.

Synodontidae

The great majority of synodontids were Synodus (Table 1). These were taken on all but one cruise, but densities were markedly higher than average on 77-11 (Table 3) when over a fourth of the specimens were taken. There was, however, no significant difference in size composition between the 77-11 specimens and those from the remainder of the cruises. The overall median length was 17 mm and 75% of the specimens were between 10 and 26 mm. Although the IK caught all but one of the 14 specimens over 27 mm, there was no significant difference in size composition between IK and BB catches (Fig. 1). The estimated density from the BB data was considerably higher than that from the IK. Larvae from the SB catch were significantly smaller in size than those from the BB catch (Fig. 1), and the largest in the SB catch (21 mm) was only 4 mm longer than the median size for the BB catch. For larvae <22 mm, the estimated density from the SB catch was almost twice the BB estimate.

Trachinocephalus myops was taken between August and March. Only one specimen was taken by the SB. The IK captured 9/11 of specimens over 22 mm, while the BB captured the same fraction of those 22 mm or less. The remaining synodontids taken were either definitely or probably small *Saurida*.

Ophidiidae

Neither of the two types of ophidiid larvae were taken frequently (Table 1). For both, sizes between small larvae and nearly transformed individuals were absent. Fourteen of the *Brotula multibarbata* were 3–13 mm long, while the

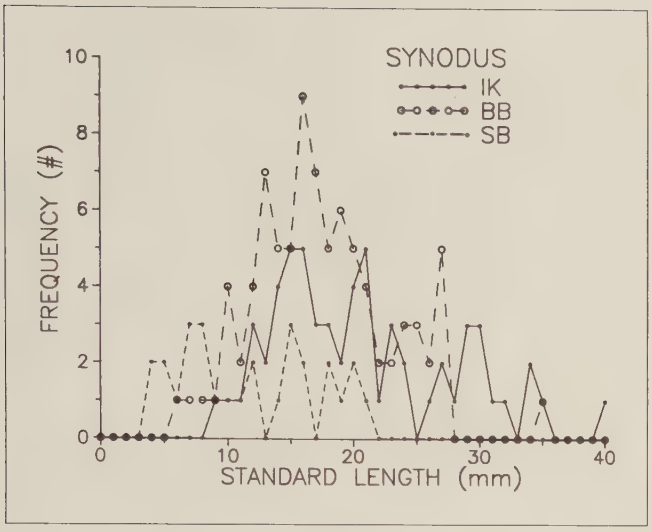

Figure 1
Size frequencies of larvae of *Synodus* caught by a 3-m Isaacs-Kidd midwater trawl (IK, solid line, small solid circles), 1.25-m diameter bongo nets (BB, longer dashed line, large open circles), and 70-cm diameter bongo nets (SB, shorter dashed line, small solid circles) in oceanic waters near Oahu, Hawaii, 1977–78.

remaining four were 26–60 mm. Five specimens of ophidiid X were 6.5–15 mm and the other nine were 27–40 mm. Ophidiid X may prove to be either a pelagic or deep benthic rather than a nearshore species.

Holocentridae

Holocentrine larvae were taken only in July, August, and September. Seven specimens (tentatively identified) were small (1.5–2.5 mm), early preflexion larvae taken on 77-08. Ten of the 17 myripristine larvae were taken in October, but the remainder were scattered throughout the other cruises.

Zeniontidae

Zenion was taken on two-thirds of the cruises; captures were scattered throughout the year. Almost half the specimens taken (13) were >13 mm long and taken by the IK. Two large specimens (30 and 38 mm) were females carrying vitellogenic oocytes. Thus it is not certain that *Zenion* should be considered a nearshore species.

Scorpaenidae

Scorpaenids <5.5 mm long could not be reliably identified beyond family, but, like the larger larvae, most were probably Scorpaeninae (Table 1). Among the larger scorpaenines, *Scorpaenodes* spp., which were distinguishable by the parietal spines and dorsal spine counts, were taken on most cruises, but not in large numbers. The remaining scorpaenines all had the same fin ray counts (D = XII, 9; A = III, 5; P1 = 16, or rarely 17, 18) and could belong to any of the genera known from Hawaii except *Scorpaenodes*. There were obviously a great many forms among these specimens, but only two could be reliably distinguished on the basis of body pigment. All but one specimen of scorpaenid E were taken between November and March, and all but one of scorpaenid F in February or March.

A distinct form attributed to *Dendrochirus barberi* on the basis of fin ray counts was taken in a few samples. The remaining scorpaenids were Setarchinae. Four of these (4.5–9 mm) were *Setarches* sp. The others were either definitely or tentatively *Ectreposebastes*. (Some individuals less than 5.5 mm could not be definitely identified.) *Ectreposebastes imus* is a deep-water species which migrates well off the bottom at night (Struhsaker 1973); adults have occasionally been taken in IK tows at depths between ca. 500 and 1000 m in the same study area.

Apogonidae

Other than a few specimens of *Pseudamiops* taken between July and November, the apogonids collected (Table 1) were all apogonines that were not identifiable to species. At least four different forms were taken, but the distinguishing features, principally body shape and pigment on the fin rays, appeared to become less useful with increasing size. Consequently, many larger specimens and those with damaged fin rays could not be assigned to one of the forms. Apogonine A, an elongate form, was represented by about 40 specimens 4–22 mm long. Twenty of these were taken in 77-08, but the rest were scattered throughout the year. A stubbier form (possibly *Apogon erythrinus*) was represented by at least 10 individuals 3.5–10 mm long; these captures were scattered throughout the year. Two other forms, intermediate in body shape and similar to each other, were represented by six or fewer individuals. The size ranges of apogonines captured were about the same for both BB and IK, but the BB density estimate was much higher than the IK's (Table 3). Those captured by the SB were mostly 4–6 mm individuals.

Carangidae

All but one of the carangid larvae were taken from July through November. The great majority were taken on 78-10, and estimated densities for that cruise were much higher than for the other cruises (Table 3). About 80% of the carangids were small (2–6 mm). Based upon pigmentation, body shape, and head spination, all but five of these were almost certainly either *Decapturus*, four species of which occur in Hawaii, or *Selar crumenophthalmus*. Both genera are coastal pelagic and, particularly for *Decapturus*, spawning could occur well away from shore. Among the

larger larvae, both genera were identified based on fin ray counts (Table 1). Pigmentation differences indicated that at least two forms of *Decapturus* were present. *Scomberoides lysan* was taken in a few samples, and several larvae of *Seriola* were taken in a single sample from 78-10. The more strictly demersal types of carangids were represented by only two and possibly three small *Caranx* larvae.

Chaetodontidae

Except for a single larva of *Forcipiger*, all chaetodontid larvae were apparently *Chaetodon*. Dorsal and anal counts from 31 large, undamaged individuals were XII-XIII, 21-24 and III, 17-20, respectively. Most were XIII, 21-23 and III, 18-19. While species or even species groups could not be discriminated by counts, clearly several of the Hawaiian species of *Chaetodon* with higher counts were not represented in the samples. *Chaetodon* larvae were taken on all but four of the cruises, but 16 were taken on 78-03 and 78-04. Seven of the total of eight with twelve dorsal spines were taken on 78-02 or 78-03. Most *Chaetodon* were taken by IK; the BB, however, caught four of the five specimens <6 mm long. The remaining specimens were almost completely separated into two size groups: 11 (8-12 mm) and 19 (19-31 mm). Seven of the smaller group were the specimens with twelve dorsal spines taken in February or March.

Lutjanidae

Lutjanid larvae were taken almost exclusively in the late summer and fall. Over two-thirds of the *Lutjanus* larvae were small (3-5.5 mm) individuals taken in 77-08 when density estimated from the BB was over $1/10^3 m^3$ (Table 3). One small individual was taken in June and two in July. The larger ones were taken from August through October of both years. All *Aprion virescens* were taken in August, and *Pristopomoides* larvae were taken from July through October.

Mullidae

Over half (130) of the mullid larvae were small (<5 mm) individuals taken by BB or SB tows. These were most abundant in 77-08 (Table 3) when 139 of the mullids were taken; 69 and 35 were taken in single SB and BB tows, respectively. The 78-10 and 78-11 cruises caught 18 and 33 mullids, respectively. The remainder, including all sizes, were scattered throughout the rest of the cruises. Presumably owing to extrusion through the IK and BB meshes, the SB density estimates were much higher than for the larger nets. Even if only the mullids >9 mm were considered, the SB density estimates were by far the highest and the IK's the lowest (Table 3).

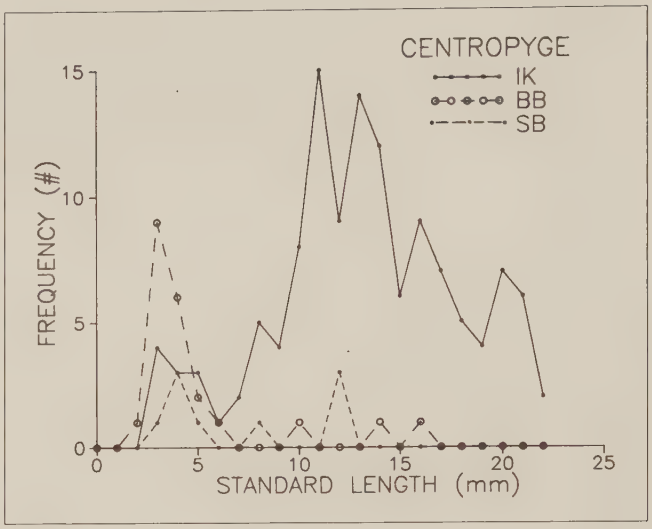

Figure 2

Size frequencies of larvae of *Centropyge* caught by a 3-m Isaacs-Kidd midwater trawl, 1.25-m diameter bongo nets, and 70-cm diameter bongo nets in oceanic waters near Oahu, Hawaii, 1977-78. Format as in Figure 1.

Pomacanthidae

All pomacanthid larvae were apparently *Centropyge* (Table 1). For sizes between 5 and 15 mm, a darkly pigmented form (L3) with the third dorsal spine much longer than the fourth could be clearly discriminated from a paler form (S3) with the third spine only slightly longer than the fourth. There were no differences among smaller individuals, and the differences in pigment and relative dorsal spine length were often less clear in larger, near-metamorphic specimens. Dorsal/anal fin ray counts of *Centropyge* L3 were 15-17/16-17 (rarely 18); most individuals were either 15/16 or 16/17. Counts for *Centropyge* S3 were 16-17/17-18, with most counts 17/17 or 17/18. Based upon available meristic data for Hawaiian *Centropyge*, L3 is probably *C. fisheri*, a deep-water species, and S3 is probably *C. potteri*, the common shallow-water species.

Centropyge L3 was taken far more frequently than S3 and on all but two cruises. (About a third of the L3's were, however, taken in 78-03.) *Centropyge* S3 was taken only from February through July; 12 of the 17 total were from 78-03. The small *Centropyge*, identifiable only to genus, were taken only in May, August (both years, 19 of the total of 26 specimens), and October (both years). Most of the *Centropyge* (pooled data) were large individuals; 76% were >7 mm long. All but seven of these were caught by the IK. The size composition of the IK catch was significantly different from those of either the BB or SB (Fig. 2). While the latter two nets caught most of the larvae <7 mm long, the largest larva caught by the SB was only equal to the

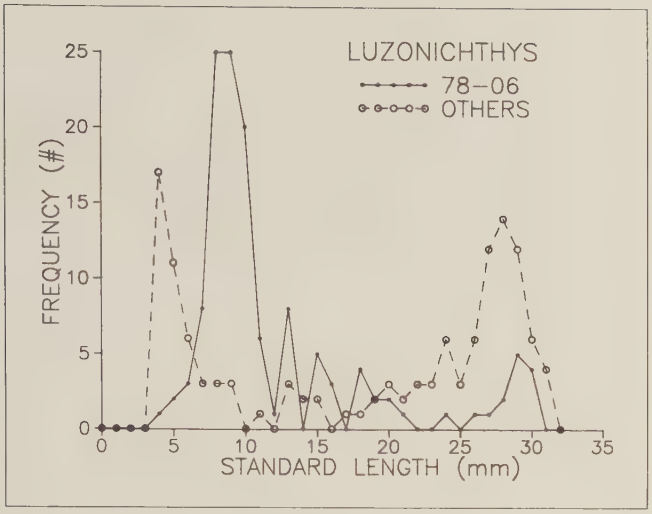

Figure 3
Size frequencies of larvae of *Luzonichthys earlei* taken in June 1978 (solid line, small closed circles) and all other cruises (dashed line, large open circles) in oceanic waters near Oahu, Hawaii, 1977–78.

median sized IK catch (12 mm). Only two BB specimens were >12 mm. Not surprisingly, the SB and BB gave higher estimated densities than the IK for the small *Centropyge* larvae, but the IK appeared to sample the large larvae much more effectively (Table 3).

Serranidae

The most frequently taken serranid was the anthiine, *Luzonichthys earlei*. (Larvae of this species, identified as "probably *Anthias* sp." are illustrated by Leis and Rennis 1983, fig. 17.) It was taken on every cruise, but 50% of the total catch was of relatively small individuals taken in June. The June larvae from all three types of gear were dominated by 7–11 mm individuals, which made up 64% of the catch (Fig. 3). Larvae of this size were a minor fraction of catches from the rest of the year; 77% of those from other cruises were metamorphic or apparently metamorphosed individuals >20 mm long. As might be expected, the small *Luzonichthys earlei* were more effectively sampled by the SB and BB (Table 3). Even for large larvae and juveniles from all cruises, the BB and SB estimates were similar and considerably higher than that from the IK data. The maximum size captured by the SB was only 2 mm smaller than the largest IK specimen.

Four forms of serranid larvae were probably *Anthias*. Serranid A was taken only from December through March; 65 of the 70 specimens were from 78-03. All but four Serranid A larvae were relatively large (10–18 mm). Serranid A′ was very similar to Serranid A and was represented in the samples by only three small and questionably identified specimens. On the basis of other material from the study area, particularly six large individuals taken in May 1974, it appears distinct from Serranid A. All known captures of this form were from May through August. Both these forms have nine anal rays. On the basis of dorsal ray counts, Serranid A is probably *Anthias ventralis* and Serranid A′ is probably *A. fucinus*. Serranid B and Serranid C both have seven anal rays, and were very distinct from each other. Serranid B was taken at almost all times of the year, while Serranid C was taken only from February through July. Based on fin ray counts, the former is probably *A. bicolor*, and the latter, *A. thompsoni*.

The only other serranid form taken more than a few times, Serranid D, was taken throughout most of the year. This form, whose fin ray counts were most similar to those of *Odontanthias fuscipinnis*, apparently metamorphoses at a smaller size than the above serranids; the largest specimens already appeared metamorphic and several had scales. At least five other types of serranid larvae were taken. Except for one damaged specimen whose counts were those of *Liopropoma*, all others were anthiines, but had counts not directly attributable to any known Hawaiian species. There were also several types among the small, pre-flexion serranid larvae taken. Many showed some resemblance to Serranids B, C, or D, but direct "links" between small specimens and the series of larger individuals were not available. Surprisingly, almost none of the small, preflexion serranid larvae appeared likely to be *Luzonichthys earlei*, the most frequently taken serranid larvae.

Pseudogrammidae

All but one pseudogrammid larvae had fin counts of *Pseudogramma polyacantha*. Most (80%) of the specimens were taken in either 78-02 or 78-03, but the others were scattered throughout the year. A single larva with counts of either *Aporops* or *Suttonia* was taken in 78-08.

Symphysanodon

Almost 70% of the *Symphysanodon* larvae were taken in 78-03; 1–8 individuals were taken on 10 other cruises scattered throughout the year. The size composition of the March catch differed significantly from that of the remaining catches. The former was dominated by 11–16 mm larvae, while the latter were mostly <8 mm (Fig. 4). The BB data provided higher estimates of density than did the IK (Table 3). The SB was apparently effective at catching only the small larvae, and caught none at all on the peak 78-03 cruise. Three much larger *Symphysanodon* (50–56 mm) were taken in the study area by a 5-m IK trawl sample in May 1974. Gill raker counts on these indicated they were *S. maunaloae*.

Sphyraenidae

Sphyraena larvae were taken on only seven cruises and mostly in the fall (33% in 77-08 and 42% in 78-10). Most

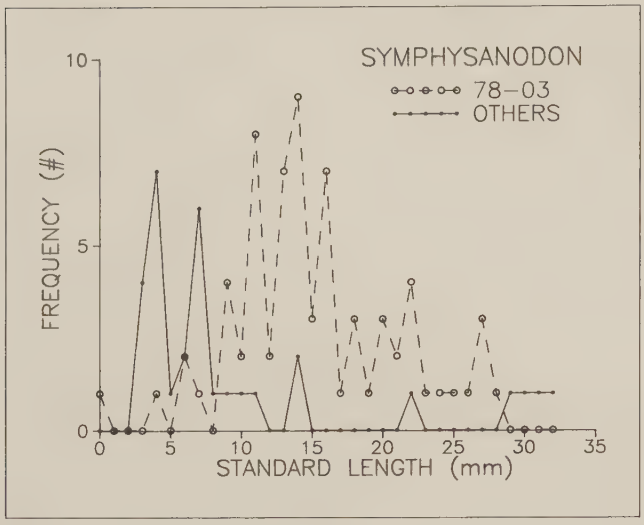

Figure 4
Size frequencies of larvae of *Symphysanodon* taken in March 1978 (dashed line, large open circles) and all other cruises (solid line, small closed circles) in oceanic waters near Oahu, Hawaii, 1977–78.

were taken by the BB, but the size composition from all three types of gear was similar.

Labridae

At least 13 different forms of labrids were represented, many of them by substantial numbers (Table 1). The most abundant labrid (and second most abundant taxon collected) was Labrid S, probably *Cheilinus* (*cf.* Leis and Rennis 1983, fig. 49B). It was taken on all cruises. There was no indication of a seasonal trend in abundance or size composition. The highest density observed, based on BB data from 78-07, was only about twice the mean (Table 3) and not markedly higher than that for several other cruises. Most were taken by IK or BB. Despite the larger volumes sampled by the IK, the BB caught more individuals than the IK and provided higher estimates of density than either the IK or SB (Table 3). Size compositions from the IK and BB were similar; the peak numbers were at 6–6.5 mm with few <5 mm and none >8 mm. The SB caught few >4.5 mm.

Two other forms of the tribe Cheilinini were also taken frequently. Labrid B (probably *Cirrilabrus jordani*) was taken on all but three cruises, but 71% were taken in either 78-07 or August (both years). Similarly to Labrid S, the largest specimens were only 8 mm long. Labrid N (*Pseudocheilinus* sp.) was taken on all but two cruises. Except for a high catch on 78-03, most were taken on late summer and fall cruises. Labrid N apparently reaches considerably larger sizes in the plankton than either of the two other Cheilinini taken. The BB provided higher density estimates than the IK for Labrids B and N; the SB estimate for the latter was similar to that of the BB (Table 3).

The most frequently taken labrid of the tribe Julidini was Labrid 3 (probably *Pseudojuloides cerasinus*, *cf.* Miller et al. 1979, as "Labrid L-3"). Labrid 3 was taken on all but 4 cruises, but density was markedly higher than average on 78-03 (Table 3). Size composition overall was bimodal with about 30% of the larvae in the 4–6 mm range and over 50% >11 mm (Fig. 5). The SB provided the highest density estimate for the small larvae. The BB provided a higher estimate than the IK for larvae >11 mm, but there was a significant difference between the two nets in size composition of the catch. The IK catch was dominated by larger larvae than that of the BB (Fig. 5).

Labrid T (either *Thalassoma* or *Gomphosus*, *cf.* "Thalassoma" of Leis 1983) was taken on all cruises, but 75% of the specimens were taken from 77-10 to 78-03. Size composition of larvae from this period was similar to that of the remaining larvae. Most Labrid T larvae and almost all >6 mm were taken by IK or BB. There was no difference between the size compositions of IK and BB catches, but the latter provided a much higher density estimate (Table 3).

Two forms of the tribe Novaculini were taken regularly. Labrid G (*Cymolutes lecluse*) was taken on almost all cruises, but 75% of the catches were from February through May. The BB and SB provided much higher density estimates than the IK (Table 3). The size compositions of Labrid G from all three nets were similar; catches were dominated by large, ⩾11 mm, larvae. Labrid X (*Xyrichthys*) was very similar in form to Labrid G, and could not be unequivocally discriminated from it until the dorsal fin elements were complete (or undamaged). This accounted for the large number of questionably identified specimens in Table 1. Even including the questionable specimens, Labrid X was absent from samples from April through July, and all but four specimens were taken either from October through November (both years) or from February through March.

Four forms of labrid larvae had the same fin counts (D/A:IX, 12/III, 12) as several genera of the Julidini and of *Novacalichthys*. Labrid O (*cf.* Leis and Rennis 1983, fig. 49D) was taken in most months, but over half the total specimens were from 78-02 and 78-03. Labrid E, a very elongate form, was absent from most of the late summer and fall cruises and was most frequently taken in 78-03. (Even in the largest specimens of Labrid E, it was difficult to discriminate the last dorsal spines from the first dorsal rays, and the dorsal fin counts could conceivably be XI, 10.) The minimum size captured for both these species was fairly large compared to the other labrid types. Two other less frequently taken forms with the same counts were Labrid T′, which was very similar to Labrid T and was probably one of the Julidini, and Labrid D, a deep-bodied form. Other, infrequently taken forms were Labrid S′, which resembled Labrid S but had counts of either

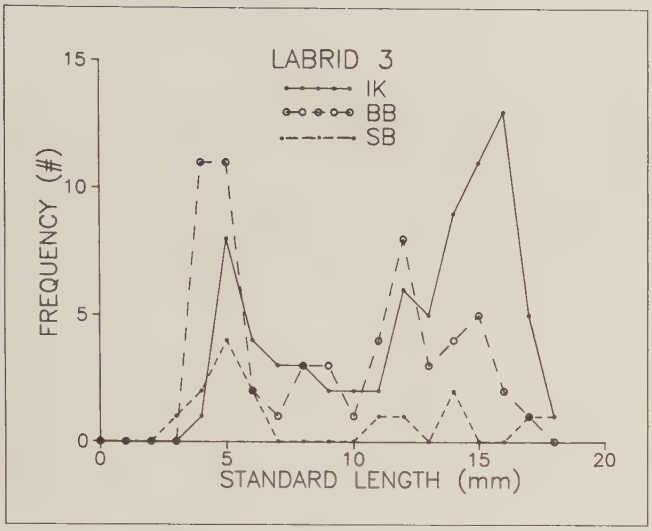

Figure 5
Size frequencies of Labrid 3 larvae caught by a 3-m Isaacs-Kidd midwater trawl, 1.25-m diameter bongo nets, and 70-cm diameter bongo nets in oceanic waters near Oahu, Hawaii, 1977–78. Format as in Figure 1.

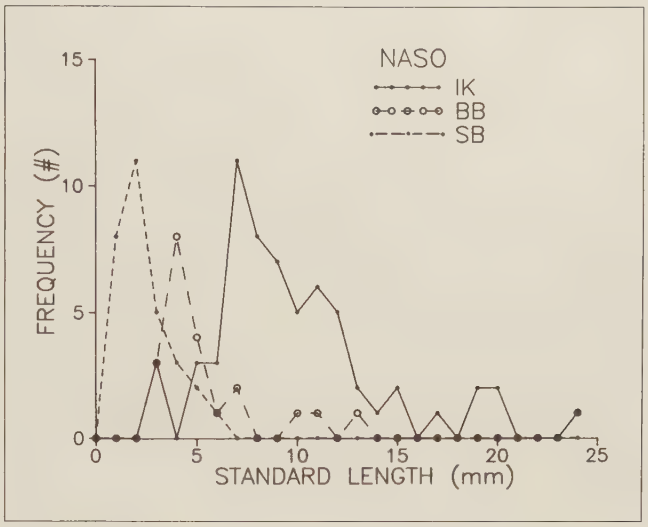

Figure 6
Size frequencies of larvae of *Naso* caught by a 3-m Isaacs-Kidd midwater trawl, 1.25-m diameter bongo nets, and 70-cm diameter bongo nets in oceanic waters near Oahu, Hawaii, 1977–78. Format as in Figure 1.

Labroides or *Suezichthys*, and a single specimen with counts of *Polylepion russelli*.

Scaridae

The most frequently taken scarid larvae were scarines with relatively round eyes (Table 1). Scarine A had melanophores on the dorsal edge of the caudal peduncle; Scarine B lacked this pigment. The size ranges of the two forms overlapped but specimens of Scarine A tended to be smaller. Thus the scarine larvae could represent only one form which loses the dorsal pigment at variable size. Both scarine forms were taken throughout the year, with the highest catch (12) in 78-03. The scarid larvae with distinctively narrow eyes, presumably *Calotomus*, were mostly larger than the largest scarine larvae, but were less abundant. They were taken on all but 5 cruises; almost half the total were, however, taken in 78-02 or 78-03.

Pomacentridae

Most of the pomacentrid larvae taken (Table 1) were small (3–6 mm) with fin elements insufficiently developed for further identification; several were only tentatively identifiable as pomacentrids. Almost all of these small larvae were taken on one of three cruises: 77-08, 78-03, or 78-11. Larger individuals were identifiable to genus. *Chromis* A, which was taken only in 78-02 and 78-03, had counts of either *C. struhsakeri* or *C. verater*. *Chromis* B, which was taken in 78-02, 78-03,and 78-06, had counts within or close to the ranges of either *C. agilis* or *C. hanui*; some could conceivably have been *C. leucurus*. *Chromis* C were probably either *C. acares* or *C. vanderbilti*. A few specimens each of the other known Hawaiian pomacentrid genera were taken (Table 1).

Acanthuridae

Larvae of *Naso* were taken on almost all cruises but were more abundant during June-November. Eighteen very small (1–2 mm), tentatively identified specimens that had not yet developed the "acronurus" body form were taken in 78-10 and 78-11. The three largest individuals (one at 37 mm and two at 34 mm) were exceptional catches; the next largest were 24 mm. Only 5% of the larvae were >20 mm long and only about 25% were over 10 mm. The SB did not catch any *Naso* over 6 mm long. The size compositions of the BB and IK catches were significantly different and indicated that the IK was more effective for the large Naso larvae (Fig. 6). For larvae >6 mm, however, the density estimate from the BB was slightly higher than that from the IK (Table 3). Both dorsal and anal fin ray counts of 64 individuals ranged from 27–30, and did not exclude any known Hawaiian species. Most counts, however, were 27–29/27–29 indicating that these larvae were most likely *N. unicornis*.

Small (≤6 mm) acanthurid larvae which could not be identified to genus were taken in low numbers throughout most of the year. Except for a few *Zebrasoma flavescens*, the larger individuals had either eight or nine dorsal spines. The former were considered *Ctenochaetus* and the latter, *Acanthurus* in spite of known, but infrequent, overlap in

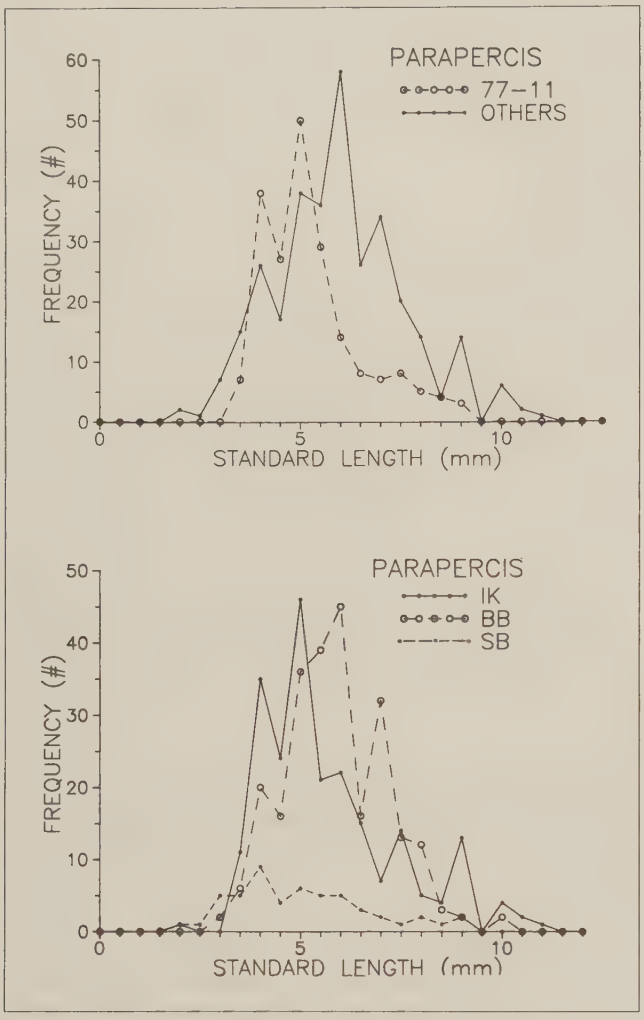

Figure 7

(**Upper**) Size frequencies of larvae of *Parapercis* taken in November 1977 (dashed line, large open circles) and all other cruises (solid line, small closed circles) in oceanic waters near Oahu, Hawaii, 1977–78. (**Lower**) Size frequencies of larvae of *Parapercis* caught by a 3-m Isaacs-Kidd midwater trawl, 1.25-m diameter bongo nets, and 70-cm diameter bongo nets. Format as in Figure 1.

counts of the two genera. Dorsal and anal ray counts of 41 *Acanthurus* indicated that one was *A. glaucopareius*, but the remainder were within the ranges of almost all Hawaiian species. Most counts were 25–26/23–25 indicating that species with low counts (*A. triostegius* and *A. olivaceus*) were represented by few if any larvae. The three species most likely to have counts within this range were *A. leucopareius*, *A. nigrofuscus*, and *A. xanthopterus*. Dorsal and anal ray counts of 40 *Ctenochaetus* were 25–27 and 23–25, respectively, and all within the range for *C. strigatus*. Only four specimens could have possibly been *C. hawaiiensis*.

Acanthurus were taken throughout most of the year and on all but five cruises. Almost three quarters were taken on 78-02 or 78-03. All but five *Ctenochaetus* larvae were taken on 78-02 or 78-03, and it was absent from 10 of the 13 remaining cruises. As was the case with *Naso*, the two *Acanthurus* and three *Ctenochaetus* >20 mm were exceptional captures; others were all <16 mm long. Size compositions of the IK and BB catches were similar, but the SB appeared effective only for the larvae <8 mm. For the peak months (78-02 and 78-03), the BB provided much higher estimates of density than the IK for both genera (Table 3).

Parapercidae

Parapercis larvae were the most numerous type taken in the samples. All large individuals with completely formed dorsal and anal fins were *Parapercis schauinslandi*, and there were no indications of more than one form among the smaller larvae. *Parapercis* were taken throughout the year. Catches varied greatly between cruises but without any apparent seasonal pattern. Highest catches were in 77-08 (91 individuals), 77-11 (200), and 78-03 (87). The high catches in 77-08 and 78-03 were largely due to single BB samples, but all three types of gear and most individual tows captured higher than average numbers in 77-11. Size composition of both IK and BB catches from 77-11 differed significantly from catches by these nets on the remaining cruises. The larvae from 77-11 were dominated by smaller individuals than those from the rest of the cruises (Fig. 7).

For data from all cruises, the SB catches of *Parapercis* differed significantly in size composition from those of the IK and BB; larvae >4 mm were relatively poorly represented in the SB data (Fig. 7). The size compositions of the BB and IK catches were more similar, but still differed significantly. Larvae 6–8 mm tended to be relatively better represented in the BB data (Fig. 7). The same trend was present, but not significant, in the 77-11 data alone. For the pooled data, the BB density estimate was slightly higher than that of the SB and much higher than that of the IK (Table 3). For 77-11, the SB estimate was by far the highest, but was based on only two tows one of which collected 15 *Parapercis* larvae—almost a third of the total SB specimens from all cruises.

Blenniidae

Most blenny larvae were salariines (Table 1). These were taken on nine cruises scattered throughout the year, but over two-thirds of the total were from either 77-08, 78-03, or 78-11. All but three specimens were either under 8 mm or over 15 mm long. The BB caught slightly more of the smaller group and only slightly fewer of the larger than did the IK. The SB specimens were mostly small, but the largest, 27 mm, was almost as large as the largest IK specimen. Most of the large specimens were taken in 78-03 and most of the small ones in 77-08 and 78-11. Fin ray counts, where possible, indicated that most were probably

Cirripectes; only two of the 20 counted could possibly have been *Exallias brevis*. Some of the small specimens, without complete dorsal and anal fins, were possibly *Istiblennius* spp. Other types of blenny larvae were very infrequent. In addition to three large *Plagiotremus* sp., only one small unidentified blenniid and nine omobranchines were taken. Eight of the latter were from 77-08.

Schindleriidae

Schindleria praematura was taken on all but four cruises, but over half (25) were from 77-08. *S. pietschmanni* was taken much less frequently (Table 1); six of the seven were taken on 77-08. Within a few km of shore, S. pietschmanni appears to be the dominant species, and both species are much more abundant and routinely taken (Leis 1982).

Eleotridae

Larvae of *Eleotris sandvicensis*, a catadromous species which spawns in brackish water, were taken on all but two cruises, but appeared to be most abundant in late summer–fall. Over half were taken on either 77-08, 77-09, or 78-11. The size range taken was very narrow; 80% were 5–6.5 mm long, and over half were 6–6.5 mm. IK and BB catches were similar to each other in size composition and dominated by slightly larger larvae than in the SB catches. The SB and BB density estimates were similar to each other and far above that from the IK (Table 3).

Gobiidae

Gobiids were one of the most frequently taken families. The majority belonged to one of four relatively elongate forms. Goby A, which is probably a species of *Oxyurichthys*, was the commonest (Table 1). It was taken throughout the year and on all but five cruises, but catches were concentrated in 78-02 (30 individuals), 78-03 (22), and 77-11 (20). Over 70% of the total were >15 mm long. Goby B (probably *O. lonchotus*) also occurred throughout the year, but half were taken on either 78-03 or 77-11. Nearly 75% of the larvae were >9 mm long. Goby D-3 and Goby D-5 were very similar forms, but with different fin ray counts; the counts of each are, however, shared by several species of Hawaiian gobies. Both forms occurred throughout the year and on most cruises, but almost 30% of Goby D-3 were taken on 77-11. Size composition and maximum size caught by the IK and BB were similar for each of the above four forms, but BB density estimates were considerably higher (Table 3). For the three forms taken sufficiently often by the SB, the density estimates were similar to those from the BB.

Five less frequently taken types of goby larvae could be identified based on either unique fin counts or previous descriptions. Four of these—*Eviota epiphanes*, *Bathygobius*, *Asterropteryx semipunctatus*, and *Psilogobius mainlandi*—are known to occur at much higher densities in waters closer to shore (Watson and Leis 1974; Leis 1982; Miller et al. 1979). Most of the *Eviota* and *Bathygobius* and all *Asterropteryx* were taken in 77-08. Larvae of none of the above four species nor of *Kellogia oligolepis* appear to reach sizes comparable to the four elongate forms.

Goby R, which was taken on only five cruises, was more robust than any of the other goby larvae and also had a longer more pointed snout. The latter suggested *Fusigobius*, but Goby R's dorsal and anal ray counts were too low. Among the larvae under unidentified Gobiidae (Table 1), there were at least four more distinctive, but unidentifiable forms, none of which were represented by more than three individuals. Other unidentified gobies either did not exactly fit any of the forms mentioned above or were too damaged or too small for identification.

Microdesmidae

Ptereleotris heteroptera was taken only during August–March with highest catches during the fall months. Almost 20% of the total came from two IK samples with high catches of small individuals. Over 60% of the specimens were <12 mm long. For both the entire size range and large (>11 mm) larvae alone, the SB density estimates were higher than those of the BB and both much higher than that of the IK (Table 3). *Gunnellichthys curiosus* was taken throughout the year and on all but four cruises. Over half the larvae were longer than 20 mm with only two <10 mm. The SB caught only three *Gunnellichthys*; the largest was only 15.5 mm. The BB, however, caught almost as many larvae as the IK and provided a higher density estimate even for the larger larvae (Table 3).

Callionymidae

Callionymid larvae were taken on all but one cruise. Abundance varied greatly between cruises, but there was no obvious seasonal pattern. There were at least six and possibly more different forms among the callionymid larvae. None of the specimens, however, appeared to be *Calliurichthys decoratus*, whose larvae are common in shallow inshore areas (Miller et al. 1979). Accurate counts of dorsal and anal fin rays were possible only for the largest individuals, and only one individual, an 8.5-mm *Eleutherochir pogognathus* could be identified beyond family on the basis of counts. In most other specimens with the fins apparently developed, the dorsal/anal ray counts were 8–7/7–9. The commonest form, Callionymid A was distinguished by a rounder head profile than the others and very light or no pigmentation until about 5 mm. The other forms were distinguished solely upon pigment pattern, but intergrades or questionable individuals were frequent enough that the data were not tabulated separately. As might be expected

for such small larvae, the IK was the least effective and the SB the most effective sampling gear (Table 3).

Discussion

Gear Comparisons

For most taxa or size classes of larvae considered in Table 3, the density estimates from the IK were markedly lower than those from the BB, and the latter estimates were often lower than those from the SB. In many cases between gear differences in density estimates were accompanied by differences in size composition of the catch. Such gear specific differences were not unexpected given that the three types of gear differed in mouth size, towing speed, and mesh size, each of which would affect bias due to avoidance or mesh escapement or both. Bias due to avoidance would be expected to be less for the larger and faster of any two nets, but bias due to escapement through the meshes would be greater because of the larger meshes and perhaps, as suggested by Munk (1988), greater towing speed. The degree of each type of bias would vary with size of the larvae, but in opposite directions, and both types of bias could be operating over part or even all size ranges considered. Based on analyses of the much more abundant myctophids in the same samples, Clarke (1983) indicated that larvae less than 6–8 mm long and fish less than 25–35 mm long were seriously undersampled by the BB and IK, respectively, because of mesh escapement, but that it was unclear that mesh escapement was serious at larger sizes because avoidance of the SB and BB, respectively, may have contributed to the apparent superior performance of the larger nets for larvae or fish larger than the above size ranges.

The same difficulties in interpreting the data on nearshore larvae are exaggerated because of lower densities relative to volumes filtered—especially by the SB. Nevertheless, most of the between gear differences in estimated density and size composition appear related to differences in error due to mesh escapement. This is most nearly certain in taxa such as carangids, mullids, and callionymids, where the great majority of larvae were small ($\leqslant$6 mm) and the SB estimates were by far the highest and the IK estimates by far the lowest (Table 3). Such sizes would be least likely to avoid the SB, and losses through the meshes of the BB and especially the IK were almost certainly substantial. Error due to escapement through the meshes of the larger net was also indicated in most cases where there were significant between gear differences in size composition of the catch. In all cases except the IK-BB comparison for *Parapercis*, the catch from the smaller net was dominated by smaller fish. The differences in density estimates and size composition could have resulted from escapement of the small, more abundant larvae through the coarser meshes of the larger net. The differences in size composition could, however, have resulted in part because of avoidance of the smaller net by large larvae. In some IK-BB comparisons (e.g., *Centropyge* and Labrid 3) and many BB-SB comparisons (e.g., *Symphysanodon* and even small forms such as Labrid S and *Eleotris sandvicensis*) the smaller net appeared ineffective at sampling large larvae. If such bias due to avoidance were operating at the large end of the size range, it effectively canceled some of the losses due to mesh escapement for the large nets and means that densities of small larvae were even more seriously underestimated than the comparisons of total densities would indicate.

Several lines of evidence indicate that even the large larvae of many taxa were underestimated by the IK because of mesh escapement. For several taxa there were no differences in size composition between IK and BB catches, and for *Parapercis*, the BB catch was dominated by slightly larger fish than that from the larger IK. In these cases and also most comparisons of density estimates of large larvae only, the BB estimate was still higher than that of the IK. The IK estimate was higher than the BB estimate only for large *Centropyge* and similar to the BB estimate only for large *Naso*. Except for such deep-bodied larval types, it appears that there were substantial losses of all sizes of larvae through the meshes of the IK. Error due to mesh escapement would normally be expected to decrease with increasing size and result in differences in size compositions between the BB and IK, but results of Munk (1988) indicate that the higher speed of the IK may have resulted in a disproportionate increase in loss of larger larvae of certain taxa. Munk's results indicated that higher speed increased loss of large herring larvae but did not change loss rates for the small larvae.

The apparent superior performance of the IK for catching large *Centropyge* indicates that these robust, well-developed larvae and juveniles were avoiding the BB and certainly the SB. On the other hand, avoidance of the BB was apparently not a serious problem for the taxa whose density was better estimated by the BB for even large sizes. As mentioned above there were several taxa for which the SB appeared ineffective at capturing larger individuals, but for others, such as *Luzonichthys earlei*, the SB caught individuals nearly as large as the largest in the IK catches. The SB provided the same density estimate for large *L. earlei* as the BB. Given that the SB and, for many taxa, the BB tows sampled insufficient volumes to expect many or any captures of large, relatively rare individuals, it is possible that avoidance of the smaller nets was not a serious problem for many of the taxa collected.

The above considerations of mesh escapement and avoidance are admittedly speculative and imprecise because there were no between gear tests of any single variable such as net size without confounding differences in other variables, and the diversity of apparent effects of mesh escapement and avoidance is not unexpected given the diversity in shape, maximum size, and probable swimming and

sensory abilities of the many different taxa considered. The results overall indicate, however, that, except for its ability to sample larger volumes per unit time, the IK used here was the least effective sampler for most taxa because of losses due to mesh escapement. Where densities were high relative to volumes sampled, the SB and BB appeared to be the most effective nets for small and large larvae, respectively. Future studies of such larvae should employ mid-water trawls with finer mesh than normally used, or perhaps consider scaling up a bongo-type net to a size that can sample adequate volumes in a reasonable amount of time. The several indications that avoidance of the bridleless bongo nets was not a serious problem indicate that a larger version of the BB used here might be more effective overall than a fine-meshed midwater trawl.

Temporal Variation

For many of the abundant taxa, a large fraction of the total catch was from one or two cruises, e.g., *Synodus* and *Parapercis* on 77-11, and *Luzonichthys earlei* on 78-06. On 77-08 and 78-03, high catches of several taxa coincided. The 77-08 cruise collected peak numbers of Apogonine A, *Lutjanus*, and mullids, as well as unusually high (but not maximal) catches of carangids, *Sphyraena*, pomacentrids, *Parapercis*, and salariines. The 78-03 cruise (and to some extent 78-02) was marked by high catches of scorpaenids, *Centropyge*, serranid A, *Pseudogramma*, *Symphysanodon*, several labrids, scarids, pomacentrids, *Acanthurus*, *Ctenochaetus*, and Goby A. In all the above cases, the catches were higher than normal for at least three of the four IK samples and often for the majority of samples of both types of bongos. (The smaller nets appeared to be ineffective at sampling certain large forms, e.g., *Centropyge* and serranid A, and thus collected few or none even during peak months.) The high monthly totals consequently did not appear due to chance encounters with one or two small scale patches of high density.

Although these occasional, and often coincident, high catches could conceivably have resulted from peaks in output of eggs and larvae from the benthic populations, many were more likely the result of recent and more rapid than usual movement of water into the study area from inshore. The evidence for this is strongest for 77-08. First, the high catches were not repeated in 78-08 or any adjacent months of either year. Secondly, the high catches of several taxa, particularly *Lutjanus* and mullids, were due primarily to very small, presumably recently hatched larvae. Finally, several taxa (*Crystallodytes cookei*, omobranchines, *Schindleria* spp., *Eviota*, *Bathygobius*, and *Asterropterx*) taken exclusively or nearly so on the same cruise are known to occur routinely within a few km of shore (Leis 1982; Clarke, unpubl. data). All of these indicate that water from close to shore had been transported to the study area very recently before that particular cruise. Unfortunately, insufficient physical data were collected on any of the cruises to directly test this hypothesis.

The high catch of small *Luzonichthys earlei* in 78-06 was also unlikely due to a seasonal peak in reproduction since large *L. earlei* were taken in roughly comparable numbers throughout the year. Similarly, there were no hints of seasonality in the data for *Parapercis* or *Synodus* that would correlate with the very high catches of these in 77-11; in particular, the high catches were not repeated in 78-11. Recent movement of water from areas of high density seems the most likely explanation for these peaks, but it is difficult to explain why such water carried only one or a few species. Perhaps these were seasons when only a few species are abundant in nearshore waters. Alternatively, larval distributions around the islands may be narrowly zoned and recently transported water may have come from a zone where larvae of only one or a few taxa were present at high densities.

Data from 78-03 differed in several respects from that of other cruises which caught high numbers of larvae, and their interpretation is constrained because of inadequate data from the preceding three months and the lack of sampling from two different years. With the exception *Symphysanodon* and salariines, which tended to be larger than usual, the size composition of most taxa taken in high numbers on 78-03 did not differ from that from the rest of the cruises. The 78-02 cruise, when catches of several of the same taxa were also high, was only two weeks earlier than 78-03, there was no cruise in 78-01, and the BB was not used on the 77-12 cruise. Thus the high catches could conceivably have been the tail end of a broader, 2–3 month long seasonal peak in abundances. This seems unlikely because most, but not all, of the taxa with peaks in 78-03 were taken regularly throughout the other cruises. None are known to be more abundant close to shore, but it is conceivable that the high catches resulted from recent movement of water into the study area from somewhere (perhaps further offshore) where these taxa routinely occur at high densities.

Another possible explanation for the peak catches in 78-02 and 78-03 is that these cruises sampled available larvae much better because of higher towing speeds. For unexplained reasons, the towing speeds estimated from flowmeter data for all gears were considerably higher than average for these two cruises. (The mean speeds for 78-02 and 78-03 tows with the IK, BB, and SB were about 12%, 25%, and 45%, respectively, higher than the overall means.) This had the obvious effect of increasing volumes sampled per tow, but these differences were far from sufficient to explain the high catches. It is, however, possible that the higher speeds crossed a major "threshold" for avoidance of all types of gear by the larger sizes of larvae and that densities of larvae were actually similar to other cruises, but catches were higher because of reduced error due to avoidance for all three types of gear.

If occasional high catches of some taxa are ascribed to circulation events, seasonal trends in occurrence or abundance were evident for only a few of the frequently collected taxa. *Centropyge* S3, serranid A, and *Ctenochaetus* appeared restricted to the winter and early spring months. *Lutjanus* and indeed all lutjanids were restricted to late summer and fall; this pattern has been noted by Leis (1986) based on catches from a number of different years. *Trachinocephalus myops* and *Pterelеotris heteroptera* were taken only during August through March. Naso and several types of labrid larvae were taken over all or most of the year, but abundances were high only over shorter periods. Some of the less frequently taken taxa, such as holocentrines, also appeared to be present or more frequent during certain seasons.

Both the general lack of seasonality in abundance and most instances of apparent seasonality fail to support Lobel's (1978) hypothesis that spawning seasons of inshore fishes are timed to coincide with the period (December–June) when ocean current patterns might favor retention of larvae near the islands. The apparent seasonal peaks in abundance of some labrid larvae agree with seasonal patterns of recruitment of several Hawaiian labrids reported by Walsh (1987), but otherwise the observed patterns of larval abundance (or lack thereof) correlate poorly with Walsh's evidence for a summer peak in recruitment of many reef fishes.

Size Composition

The very early stages of inshore fish larvae are apparently only rarely transported as far offshore as the study area. For the great majority of taxa, the smallest larvae taken were at either late preflexion or early postflexion stages. Except for the coastal pelagic carangids, multiple captures of early preflexion stages occurred in only a few cases: holocentrines and mullids in 77-08 and *Naso* in 78-10. Admittedly, it is possible that there were more, but unrecognized early preflexion larvae of nearshore families present in the samples, but for reasons given in the methods section it is unlikely that the number of misidentifications were sufficient to substantially alter the above statements.

The largest specimens of the more abundant taxa were probably close to the maximum size for the pelagic stages. For the majority of abundant taxa it appeared that all sizes between late pre-/early post-flexion and the maximum size were either about equally represented or at least reasonably likely to occur in offshore waters. Eight types of larvae, however, were represented primarily by relatively large and presumably near-settlement size larvae. These were *Centropyge*, *Luzonichthys earlei* (except in 78-06), serranid A, labrids O and E, *Calotomus*, goby A, and *Gunnellichthys*. In these taxa, and perhaps for some of the less frequently taken taxa, even the early to middle postflexion stages appear to be rarely advected very far offshore.

Four abundant taxa (*Chaetodon*, *Symphysanodon*, Labrid 3, and salariines) were exceptional in that the size composition of larvae appeared bimodal. A few of the rarer taxa (ophidiids, *Polymixia*, dactylopterids, and tetraodontiforms) also appeared to be represented mostly by either very small or very large individuals. Bimodal size-frequency distributions could result from periodicity in spawning. Alternatively, the peak of small individuals could simply represent the most abundant age group while the peak at larger sizes could represent an accumulation of older individuals with a wide range of ages, but small differences in size. Victor (1986a) has shown that labrid larvae can delay metamorphosis and continue to grow for long periods after the probable minimal size and age for settlement has been reached but that growth is greatly slowed after the latter point.

Densities

The average densities of even the most abundant taxa were very low (Table 3). Only *Parapercis* and Labrid S regularly occurred at levels of $1/10^3$ m^3. Carangids, mullids, and *Luzonichthys earlei* occurred at similar or higher densities only on single cruises. For the many taxa that were taken less frequently than those in Table 3, the average densities would be on the order of $0.0001–0.01/10^3$ m^3. Because it is likely that most taxa do not occur throughout the entire 0-100 m stratum, densities within the actual depth range would be higher. Even if larvae occurred only within a 10 m deep stratum and densities thus were 10 times higher within that stratum, filtering a volume of a few hundred m^3, typical of most plankton tows, would be woefully inadequate. Even a volume of the order of 10^3 m^3 would be insufficient for all but a few taxa at a few times. As is illustrated by the results from the SB tows in this study, such volumes filtered simply would not be expected to catch most taxa.

Lobel and Robinson (1988) reported densities of $0.3–6.8/10^3$ m^3 for inshore fish larvae at five stations in and near an eddy off the island of Hawaii. These values are much higher than most averages reported here and were exceeded for only a few species on a few cruises. Lobel and Robinson's results must, however, be interpreted with caution because they are based on few samples. A single surface and a single near-surface tow, each of which apparently sampled about $1–2 \times 10^3$ m^3, were taken at each station. Consequently, the density for any taxon collected could not be less than ca. $0.3/10^3$ m^3. The 44 different density estimates in their table VI are based on only 130 specimens; 23 estimates, apparently on single captures per station. With the exception of carangids, only two nearshore taxa were taken in substantial numbers—both at the same station. More data are necessary to determine if the reported densities of these two taxa are routinely encountered, if they are only associated with eddies or similar recent transport

from inshore, or if the present study may have ineffectively sampled near-surface depths (*see* below).

Sale (1970) reported on larval acanthurids taken by a large pelagic trawl at two locations close to the area sampled by the present study. Using estimated towing speed and mouth opening of this trawl (Higgins 1970), Sale's catch data indicate that densities of acanthurid larvae were only $0.001–0.002/10^3$ m^3, about 100 × lower than those estimated from this study (Table 3). Part of the difference is due to capture of smaller and more abundant larvae by the nets used here, but even considering only the same size range as reported by Sale, the estimates from the present study are still very much higher. Apparently all sizes of acanthurids were seriously underestimated owing to escapement through the coarse (19-mm stretch) meshes of the wings of the large pelagic trawl.

Faunal Composition

The larvae collected represent most of families of Hawaiian inshore fishes, and the most abundant taxa were all from families that are abundant in the nearshore habitats. Nevertheless, several taxa that appear to be very abundant as adults in nearshore habitats were poorly represented or absent in the offshore samples. Some common taxa from shallow water areas which were absent or poorly represented were holocentrids, *Kuhlia*, *Kyphosus*, demersal carangids, and pomacentrids other than Chromis. Similar, abundant taxa from slightly deeper but still nearshore areas (Struhsaker 1973) were *Glossanodon*, *Aulopus*, *Chlorophthalmus*, *Polymixia*, and *Synagrops*. The meristics of larval *Acanthurus* and *Chaetodon* indicate that some species, such as *A. triostegis* and *C. miliaris* which are very abundant inshore, were either probably absent or at best poorly represented among the larvae collected. Although adult abundance inshore is obviously not the sole determinant of larval abundance offshore, it is difficult to postulate why the above taxa were so poorly represented. There is no indication that they differ strongly in fecundity, reproductive output, spawning mode, or larval development period from related taxa that were taken frequently. Their absence or rarity in the present samples may indicate that, even within genera, larval behavior differs enough to affect degree of dispersal to offshore waters.

It is also possible that some taxa of inshore fish larvae were absent or underrepresented in the present samples because they occur in the upper few m of the water column and were poorly sampled owing to the ship's presence directly ahead of the nets. With the exception of the carangids, the most important taxa from the present study are either absent or relatively poorly represented in Lobel and Robinson's (1988) data from near surface tows in oceanic waters off the island of Hawaii. At one of their stations, larvae of holocentrids and the pomacentrid *Abudefduf abdominalis* occurred at very high densities. Neither of these were taken very frequently during the present study and may, like some of the other poorly represented taxa, prove to be more abundant very close to the surface.

The inshore fish larvae from the study area were not dominated by taxa with relatively large larvae. Although larvae of several abundant families reach rather large size (15 mm or more) before metamorphosis, families with small size at metamorphosis (parapercids, eleotrids, callionymids) were, if anything, more abundant. Within the most abundant family, the labrids, there is a great range of maximum sizes of larval types (Leis and Rennis 1983). Several forms of labrids taken in this study reach almost 20 mm as larvae, but the most abundant labrid, Labrid S, and Labrid B, the sixth most abundant, apparently metamorphose at less than 10 mm.

Although relevant data on larval stage durations are few, they indicate that at least the labrids taken in the study area were not dominated by genera with long larval stage durations. Assuming my generic identifications are correct, the Hawaiian species of the two most abundant labrids, Labrid S (*Cheilinus*?) and Labrid 3 (*Pseudojuloides*?) have much shorter larval stage durations than those of other tentatively identified genera such as *Thalassoma*, *Cymolutes*, and *Xyrichthys* (Victor 1986b). In contrast, available age data on pomacentrids (Thresher et al. 1989; Wellington and Victor 1989) indicate that Hawaiian species of the most frequently taken genera—*Chromis*, *Stegastes*, and *Plectroglyphidodon*—tend to have longer larval stage durations than do the infrequently taken *Dascyllus* and *Abudefduf*.

Taxa with unique pelagic "prejuvenile" stages (acanthurids, chaetodontids) or whose larvae possess long spines (e.g., *Symphysanodon*) or other apparent modifications for pelagic existence were abundant in the present samples but were far outnumbered by labrids, parapercids, gobiids, and mullids, none of which show obvious special modifications for pelagic existence. The most abundant serranid larvae, *Luzonichthys earlei*, was relatively nondescript and had less developed spines than most other serranid larvae. While it is possible that taxa whose larvae are large, long-lived, or modified for pelagic existence will better survive dispersal offshore, occurrence and abundance in offshore waters are not well predicted by larval size, duration, or morphology.

Most of the larvae from this study were of taxa which spawn pelagic eggs as adults, and the three most frequently taken families (labrids, parapercids, serranids) are pelagic spawners. Predominance of larvae of pelagic spawners was not, however, overwhelming. The demersally spawning gobiids were fourth in number of specimens, and six other demersally spawning families (Microdesmidae, Eleotridae, Apogonidae, Pomacentridae, Blenniidae, Schindleriidae) were among the top 20 families taken. The observed dominance of pelagic spawners does not seem surprising given that most families of inshore Hawaiian fishes are pelagic spawners. Leis and Miller (1976) reported a similar

dominance by larvae of pelagic spawners in offshore waters of Hawaii and contrasted this with evidence of dominance by larvae of demersal spawners in inshore coastal waters. They concluded from this, without comparison of inshore and offshore densities, that larvae of pelagic spawners tend as a group to be more abundant in offshore waters and those of demersal spawners more abundant close to shore.

Comparison of the results of the present study with those of Leis (1978, 1982) from inshore waters off the same coast of Oahu indicate that not only are the conclusions reached by Leis and Miller (1976) not supported, but also that their proposed general differences in dispersal patterns between larvae of demersal and pelagic spawners are questionable. Leis's (1978, 1982) data show that dominance by larvae of demersal spawners in inshore waters is due to few species—primarily a tripterygiid, a schindleriid, and a gobiid. Their densities were much higher than those of any taxon taken offshore in the present study. Larvae of pelagic spawners were absent or very rarely taken; however, so were larvae of most demersally spawning taxa taken in the present study. Leis and Miller (1976) noted that larvae of certain demersal spawners (salariine blennies and *Chromis*) were apparent exceptions to their proposed trend. In fact, the few species of demersal spawners which dominate inshore are apparently the exceptions. Smith et al. (1987) report that inshore areas adjacent to deep water in the Caribbean are dominated by "clupeids, blennioids, and gobioids." Although the number of species involved is not given, it appears that high abundances of just a few types of larval fishes may characterize inshore waters in other areas bathymetrically similar to Hawaii.

Furthermore, Leis's results—like those of other studies of ichthyoplankton in inshore Hawaiian waters—were based on plankton tows which filtered only a few hundred m^3 per sample. Even if larvae of pelagic spawners and the "missing" types of demersal spawners had been present inshore at densities 10–100 × those observed offshore, only an occasional capture would be expected by such small volume samples. While small volume samples are adequate to show that certain taxa are much more abundant inshore than offshore, inshore waters must be sampled with procedures comparable to the BB or IK tows used in the present study in order to determine if any larval forms or sizes are ever more abundant offshore than inshore.

If, as hypothesized above, the occasional and often coincident high catches of certain taxa in offshore waters were due to recent movement of surface waters, then some of the taxa taken offshore must occur somewhere else at considerably higher densities than usually observed in these samples. As mentioned above, *Schindleria* and certain goby larvae are known to routinely occur at considerably higher densities within a few km of shore. (Preliminary analyses of samples recently collected off windward Oahu indicates that certain other taxa such as *Lutjanus* and holocentrids are also more abundant closer to shore.) If densities of more taxa prove to be higher somewhere between the location of the present study and shore, it may mean that nearshore larvae which occur more than a few km offshore are normally a minor and perhaps inconsequential fraction of total potential recruits to island populations and are of consequence only for zoogeographic dispersal.

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